

The Deep Web, dark matter, metabundles and the broadband elites:

Do you need an informaticist?

Gary Holden

New York University

Gary Rosenberg

Mount Sinai School of Medicine

The final version of this manuscript for citation is:

Holden, G. & Rosenberg, G. (2003). The Deep Web, dark matter, metabundles, and the broadband elite: Do you need an informaticist? *Social Work in Health Care*, 36(4), 1-18.

The first author may be contacted at: Room 407, MC: 6111, Ehrenkranz School of Social Work, New York University, 1 Washington Square North, New York, NY 10003, gary.holden@nyu.edu

Abstract

The World Wide Web (WWW) is growing in size and is becoming a substantial component of life. This seems especially true for US professionals, including social workers. It will require effort by these professionals to use the WWW effectively and efficiently. One of the main issues that these professionals will encounter in these efforts is the quality of materials located on the WWW. This paper reviews some of the factors related to improving the quality of information obtained from the WWW by social workers.

Key terms:

social work practice

clinical decision making

information quality

knowledge dissemination

Internet, World Wide Web, WWW

Introduction

Size of the WWW

Estimates of the *size* of the WWW continue to increase and they vary widely. While the major search engines do not claim to cover the entire WWW, the size of their indices provides us with a low estimate of the size of the WWW. For instance, FAST appears to have the largest index as of June, 2002 - 2.1 billion pages (Search Day, 2002). At the other end of the spectrum we encounter a much larger mass of dark matter. As noted by Sherman and Price (2001) this dark matter contains those:

[t]ext pages, files, or other often high-quality authoritative information available via the World Wide Web that general-purpose search engines cannot, due to technical limitations, or will not, due to deliberate choice, add to their indices of Web pages. Sometimes also referred to as the “Deep Web” or “dark matter” (p. 57).

Sherman and Price (2001) estimated the dark matter to be 2 to 50 times larger, while Bergman (2001) estimated that in early 2000, it was 400-550 times greater than what some refer to as the visible WWW (publicly available information covered by general search engines).

Prevalence estimates: Access and uses

Use of the Internet is increasing as well (e.g., Korgen, Odell & Schumacher, 2001; National Telecommunications and Information Administration, 2000). It

has been estimated that in early 2002, two thirds of U.S. adults were online (Taylor, 2002).

The Pew Internet and American Life Project (<http://www.pewinternet.org/index.asp>) provides us with a more detailed, ongoing view of U.S. Internet use. By mid 2000, it was estimated that in America over one third of full time workers and almost one fifth of part-time workers had access to the Internet at their place of employment. In addition, almost three quarters of those full time workers reported that this access had enhanced their work-related skills (Pew Internet and American Life Project, 2000). By early 2001, over six out of ten respondents who had access at work said that they went online at least one time per day (Horrigan & Rainie, 2002a). In late 2000, nine out of ten 12-17 year olds with access reported doing research for school online and seven out of ten with access said that online materials were the primary source for their last major assignment (Lenhart, Simon & Graziano, 2001). In terms of interactions with government, by late 2001/early 2002, approximately 68 million adults in the United States had visited WWW sites representing government agencies (Larsen & Rainie, 2002). Of this group seven out of ten had done research for their job or school and slightly more than six out of ten had looked for information about a public policy or issue. Almost half had sought information regarding health or safety concerns. Most of this group used federal sites (80%) and state sites (76%). Based on a March 2002 survey, it was estimated that slightly over six of ten Internet users have sought health information online

(Fox & Rainie, 2002). Approximately four out of ten in this group were looking for mental health related information. Information quality was important for those who had sought health information online. More than seven out of ten had ignored information from a web site, typically because of concerns related to information quality. Then there are the emerging '*broadband elite*' – a group in the Pew studies who are operationally defined as “those with high-speed home connections who, on average, do 10 or more online activities on a typical day” (Horrigan & Rainie, 2002b, p. 15). It remains to be seen when (or if) the typical WWW user will increase their online activity to this level.

Comparable use data has been reported for social workers. Barnett-Queen (2001, personal communication, September, 29, 2001) found that among the licensed social workers that he surveyed in New Mexico (n=403), 87% had access to the Internet and 71% had used it during the previous year. Of that 71%, over 60%: 1] had used the Internet one or more times per month to seek resources for client services; had used the Internet one or more times per month to do research (research was not defined in the survey); and had used a search engine one or more times per month (c.f., Hughes, Joo, Kentall & Ulishney, 1999).

So we either have a large phenomenon with which many people interact or we have a much larger phenomenon with which many people interact. In either event it is a complex phenomenon that professionals must study in order to use efficiently and effectively. For example, searching FAST in August of 2002 using the following terms, we obtained the number of hits in parentheses.

- “social work” (1,507,217)
- “social welfare” (461,055)
- “social work” and “mental health” (274,917)
- “social work” and “depression” (131,634)
- “social work” and “depressed mood” (494)

How does the time-pressed social worker filter this avalanche of information?

This article will selectively review the recent literature (c.f., Wathen & Burkell, 2002) to highlight some of the components of a key issue in filtering potentially relevant online information: information quality.

Information Quality

The healthcare provider as knowledge worker

Westberg and Miller (1999) repeat Levinson’s (1983) view of the physician as an information manager. That conceptualization is revised here to apply to social workers (c.f., Gambrill, 2001, p. 229). Social workers can be viewed as information managers who acquire, evaluate, store, retrieve, create and apply information regarding issues such as: 1) assessment and diagnosis; 2) incidence and prevalence of psychosocial factors in client populations; 3) social service and related systems of care; 4) the selection, delivery and evaluation of specific interventions; and 5) their own cognition, affect and behavior in particular professional situations (c.f., Reid, 2002).

Burrows, Moore and Lemkau (2001) found in their needs assessment of rehabilitation health care professionals that most respondents indicated that they

delivered interventions with less than the desirable amount of information each week. Based on their review of the literature in relation to meeting the information needs of primary care physicians, Westberg and Miller reach a number of conclusions that are relevant to social work:

information needs are numerous and exist in many forms, in primary care as well as other clinical settings. Studies of information needs over the last two decades underscore the persistence of the problem. . . . while microcomputer-based software applications contain large amounts of useful information, significant barriers to the effective retrieval and application of that information remain in primary care. Users have difficulty finding the most relevant resources, are unable to master multiple applications, and require time-consuming, out-of-the-office training (1999, p. 7,11)

Westberg and Miller added that the Internet has increasingly been considered as an information dissemination vehicle, but more formal testing of this possibility is needed.

Ash, et al. (2001) focused on how health care providers (including social workers) use information in day to day practice. They used the term 'bundles' which they describe as:

organized collections of highly selective bits of information, usually derived from multiple sources, created by experts to support the performance of specific tasks in specific contexts. Bundles are often

created in informal, temporary form, using any available media, including paper but also latex gloves, paper towels, sticky notes, exam-room table covers, or tissue boxes. . . . They are a form of temporary records and mnemonic devices at the same time. Bundles appear to serve many purposes, from assisting a clinician with “thinking through” a problem at hand, to sharing a representation of current data and its interpretation, to reminding an individual of critical information in an environment characterized by frequent interruptions (Ash, et al., 2001, p. 294; c.f., Delcambre, et al., 2002).

Gorman, et al. (2000) describe *metabundles*, which are an assembly of bundles, in a particular place, related to a specific task. Moving beyond these descriptions they distinguish between two uses of digital libraries – the information seeking by professionals for particular clinical problems versus a more generalized information gathering. The authors have ignored this distinction in this discussion because quality issues cut across these categorizations.

In summary, prior work has identified high levels of information needs, the difficulties in using technological applications and the potential utility of the Internet as a solution. Researchers have begun to understand how social workers and allied professionals use information at the point of service. If the Internet is to have utility for social work practitioners, the profession will need to place high quality information in the hands of the social worker, at (or near) the point of service, without fees, 24 hours per day, 7 days per week, 365 days per year.

Burrows, Moore and Lemkau (2001) offer an example of such an approach in rehabilitation with their Point of Care, Team-based Information System (PoinTIS, <http://calder.med.miami.edu/pointis/index.html>). PoinTIS provides a WWW based information resources for patients, providers and families that are accessible at the point of care. In terms of utility, these authors report that: PoinTIS had 10,014 user sessions in December of 1999 (although many were from the host organization); that it was in fact being frequently used at the point of care; and that users perceived the site as having utility. Proprietary, electronic, clinical (medical), decision support systems – such as InfoPOEMs (<http://www.infopoems.com/index.cfm>) exist as well (Grandage, Slawson & Shaughnessy, 2002).

Obstacles to answering provider questions

Yet as we noted, practitioners in field settings are typically working in more limited time frames and they encounter other obstacles. For instance, after collecting over 1000 clinical questions from family physicians, Ely, et al. (2002) randomly selected a sample of 200 questions. They concluded that 106 of these could potentially be answered with evidence. They then attempted to answer these questions by searching the professional literature. Next, based on this experience, the authors' prior experience in practice and reports in the literature regarding obstacles to obtaining evidence to support practice, they developed a taxonomy of obstacles. Although they identified 59 obstacles they considered the following six to be the most important:

- excessive time required to find information,
- difficulty modifying the original question, which was often vague and open to interpretation,
- difficulty selecting an optimal search strategy,
- failure of a seemingly appropriate resource to cover the topic,
- uncertainty about how to know when all the relevant evidence has been found so that the search can stop, and
- inadequate synthesis of multiple bits of evidence into a clinically useful statement. (Ely, et al., p. 2).

With the possible exception of a smaller empirical literature, would the list of obstacles for social work practitioners be substantially different?

Quality issues related to searching

One could argue that five of the six key obstacles described by Ely, et al. are associated with the process of searching for information. Eysenbach & Kohler (2002) combined focus groups and a laboratory observational study to better understand how people access, and assess, health information on the web. In this observational study participants were given a series of questions and a limit of 20 minutes per question to find an answer using the web. The vast majority of attempts to answer these questions began with the use of search engines, yet few participants used more advanced search techniques such as Boolean operators (e.g., and, or, not) or search parameters (e.g., language options). Low levels of operator and modifier (e.g., +, -, "exact phrase") use has

been reported elsewhere. For instance, Jansen, Spink and Saracevic (2000) found that the Boolean operator 'and' was used most frequently, but that was used in only 8% of the 51,473 searches studied. An intriguing analysis reported from this study was the percentage of all uses of a Boolean operator or modifier that were incorrect. Incorrect use ranged from 0 (use of parentheses), to 32% (use of 'and') to 95% (use of the minus sign), although the authors note their estimates may be a bit inflated given data interpretability problems. Silverstein, Henzinger, Marais and Moricz (1999) examined over 900 million searches on Alta Vista and found that 79.6% of the searches did not use an operator or modifier.

These findings are of concern given the commonly held assumption that searches will yield more relevant results if multiple key words, exact phrases and operators (e.g., and, or, not) are used. Lucas and Topi (2001) studied the impact of search terms and operators on the relevancy of web search results in a comparison of college students and expert searchers. Although the number of search terms and operators varied according to the topic of the search, the expert searchers used more search terms and more operators, and they obtained more relevant results. Jansen (2000) presents data that may call these findings into question. Contrasting 15 simple with 15 complex searches on five different search engines, he found approximately 70% overlap in the results, and asks if the difference justifies the use of more difficult complex searches with their increased risk of mistakes. The answer probably lies in the relative quality (simple vs. complex search) of the results in that non-overlapping 30%. Jansen asserts that

simple searches may produce results that are 'good enough'. For some information problems a simple search in fact may produce satisfactory results, just as for some additional problems an advanced search may be necessary. The searcher should consider the topic, their needs for the information problem and the search engine being used before deciding what will be good enough.

Quality assessment

In the Eysenbach & Kohler (2002) studies described above, focus group participants most frequently identified web site source (e.g., association or organization vs. a person), format, quality of the writing and presence of scientific references as determinants of trustworthiness (c.f., Kim, Eng, Deering & Maxfield, 1999).

The quality of the database that one is searching is an issue as well. Because they probably have generally higher quality content (e.g., typically peer reviewed), at this point in time scholarly literature databases (e.g., Medline, PsychInfo, Social Work Abstracts) may be more trustworthy. This does not mean that they are without problems (e.g., Holden & Barker, 1990). Not only do popular WWW search engines index more non peer reviewed material, they are not always clear about relevancy rankings and in some instances allow forms of paid placement in the search results (c.f., McLaughlin, 2002). Given the newness and the rapidity of change in popular WWW search engines – it is imperative that the searcher be wary of what they find. Modern electronic databases

produce results to searches very easily. Yet searchers may not always effectively assess the quality of these results.

Moving from searching for information to making decisions about the information sources uncovered, Rieh (2002) found evidence to support the view that users make two categories of judgment in these decisions. First, when deciding which sites produced in a search they would examine first, users are making a *predictive judgment* about what they will find on the available sites. Next, during the course of visiting each site the user will make an *evaluative judgment* regarding the information there and whether they should spend more time examining it or move on to another site. Rieh found that perceptions of information quality, cognitive authority of the source and topical interest were important factors in both predictive and evaluative judgments. Of course what sounds like a rationale deliberate process should be considered in light of Jansen, Spink and Saracevic's (2000) finding that 58% of the users they studied did not view results beyond the first ten displayed on the first page of output (94% of users did not go beyond the fifth page of results). Similarly, Silverstein, Henzinger, Marais and Moricz (1999) report that 85% of users in their study only looked at the first page of 10 results. It could argued that it is not optimal search behavior to rely on the search engine relevancy rankings and only examine the first 10 or so results. This position is even more defensible given the advent of paid placement in search engine results noted above. There are times, especially when the searcher is new to the topic area, that '*virtually wandering the stacks*'

may be the best approach. This involves doing either a simple or a more advanced search (depending on the amount of material available on the topic), and then viewing more of the returns than one would when you were looking for a quicker solution. This approach takes more time, yet can uncover materials that enlighten the searcher regarding the topic at hand.

Quality & accuracy of information

Is the quality of site as determined by '*credibility*' features (e.g., source, currency, hierarchy of evidence) related to the '*accuracy*' of the information provided (proportion of the published guidelines on the health topic that are covered on the site)? Kunst, Groot, Latthe, Latthe & Khan (2002) investigated this question focusing on sites covering chronic obstructive pulmonary disease, ankle sprain, emergency contraception, menorrhagia and female sterilization. They found a small positive relationship which they interpreted as meaning that one may not always find accurate health information on sites that appear credible. There are two problems with this interpretation. First, it is based on the assumption that published guidelines should be the gold standard. Second, there are areas of the total body of health information online where guidelines have not and may never be published (e.g., lists of research centers, professional organizations, support groups, etc.).

Quality & popularity

Meric, et al. (2002) used two methods of determining breast cancer related sites' popularity: the site's rank in the first 200 hits returned from a Google

search and the number of links to the site on Google and AltaVista ('link popularity'). This process involves going to the site (e.g., for Google: http://www.google.com/advanced_search and then entering the target site's URL in the *Page-specific search: Find pages that link to the page* search window). Fallis and Fricke (2002) have described link popularity on the web as the equivalent of citation analysis. Yet, this analogy falls down in that citation analysis refers to the referencing of one set of authors' work by another (both sets presumably experts and both articles are often peer reviewed), whereas link popularity is comprised of links by both lay and research communities, on web sites that do not have such an established tradition of peer review.

The Health on the Net Foundation Code of Conduct (HONcode) proposes a set of principles covering eight areas ("Authority Complementarity Confidentiality. . . . Attribution. . . . Justifiability. . . . Transparency of authorship. . . . Transparency of sponsorship. . . . Honesty in advertising & editorial policy") that are intended to help improve the quality of information on the web (<http://www.hon.ch/HONcode/Conduct.html>, no. p). Meric, et al. found that 15% of the sites they reviewed displayed the HONcode seal, although none of these sites complied with all of the eight HONcode principles. They also found no relationship between the quality of the site and popularity, although this may have been due to methodological limitations (e.g., selection, low power). In contrast Borges, et al. (2001) reported a statistically significant positive correlation between quality (HONcode compliance) and link popularity.

Quality and particular health topics

Pandolfini and Bonati (2002) report a replication of the Impicciatore, Pandolfini, Casella and Bonati (1997) study of web sites offering advice to parents regarding managing fever in children at home. In the report of the earlier study, the authors note that while there was no consensus on all aspects of managing pediatric fever at home, only four of the 41 web pages reviewed adhered closely to the recommendations in a published set of guidelines. In the replication, Pandolfini and Bonati reviewed the 19 of the original 41 web sites that still existed along with 40 new sites. The authors restricted the analyses to English language sites and found that there had been an increase in adherence to the guidelines in the 2001 vs. the 1997 set of web sites. Similarly, McClung, Murray and Heitlinger (1998) found less than 50% compliance with Academy of Pediatrics treatment guidelines, in WWW sites discussing treatment of children's diarrhea.

Fallis and Fricke (2002) report a replication and extension of the Impicciatore, Pandolfini, Casella and Bonati (1997) study. Not only did they examine the accuracy (congruence with consensus among experts) of a series of sites focusing on the treatment of childhood fever, they correlated these ratings of accuracy with some of the indicators of accuracy that have been proposed in the literature (e.g. citations of peer reviewed medical literature). Fallis and Fricke found that sites using an organizational domain, displaying the HONcode logo

and claiming a copyright were more likely to be accurate. Other indicators were not found to be related to accuracy (e.g., currency of site, authorship, references).

In a similar vein, Griffiths and Christensen (2000) evaluated the quality of depression treatment information on 21 web sites using five ratings: concordance with practice guidelines; quality of other site material; subjective overall quality rating; accountability; and levels of evidence supporting conclusions. While they concluded that overall quality of the information was low, they found that sites that were owned by an organization and sites that had an editorial board tended to have higher quality information. One interesting finding was that while 21% of the sites recommended general practitioners/family doctors as a source of help for the treatment of depression and 12% recommended clergy/priests, only 7% recommended social workers (the same percentage that recommended teachers).

Quality assessment related tools

A variety of approaches have been developed to assist end users in obtaining higher quality information. In Wilson's (2002) review of the quality tools she reported the five following types:

- Codes of conduct (e.g., the Internet Healthcare Coalition's eHealth Code of Ethics, <http://www.ihealthcoalition.org/ethics/ethics.html>)
- Self-applied quality labels (e.g., HONcode; <http://www.hon.ch/HONcode/Conduct.html>)

- Externally awarded quality and accreditation labels (e.g., American Accreditation HealthCare Commission's Health Web Site Accreditation program, <http://www.urac.org/>)
- Guidance tools that help end users apply quality related criteria to a web site (e.g., QUICK, <http://www.quick.org.uk/>, from the Centre for Health Information Quality and the Health Development Agency in the UK)
- Filtering tools or gateways, meta-indices, or vortals. This category includes sites that have been developed by content experts in an area (e.g., OMNI, <http://omni.ac.uk/>)

Despite the emergence of such tools, Wilson concluded that quality assessment is still subjective and that quality tools can be burdensome to the end user.

In a similar vein, Gagliardi & Jadad (2002) replicated their earlier study of health information rating instruments and found that a lack of demonstrated validity of tools continues to be a problem. Although their conclusions are not framed using these terms, they are really concerned about two types of validity. Does the data generated by these new instruments show a strong correlation with the data simultaneously generated by a 'gold standard measure' (concurrent criterion validity) and does the data obtained using these new instruments show a strong correlation with the data for relevant outcomes collected at some future point (predictive criterion validity)? Whether or not these quality assessment approaches prove to be a long term answer possessing both types of validity, possible alternative approaches should be explored.

Other interventions to improve the quality of information used in practice

Expert sites or ask-an-expert services have been appearing on the WWW since the late 1990's (Janes, Hill & Rolfe, 2001). Greenhalgh, et al., (2002) describe a related possibility for health care providers.

Evidence based health care involves deriving focused questions from clinical problems, searching systematically and thoroughly for best relevant evidence, critically appraising the evidence, and applying new knowledge in the clinical context. But, although most clinicians support the notion of evidence based health care in principle and wish to use evidence based information generated by others, only a tiny fraction seek to acquire all the requisite skills themselves. . . . A study in British general practice found that the commonest reason cited for not practising evidence based health care was lack of time, followed by "personal and organisational inertia". . . Acknowledging that this resonated with their own experience, Guyatt and colleagues recently formally withdrew their call that all practitioners should become fully competent in evidence based medicine . . . and others have called for the development of pragmatic, as well as systematic, approaches to supporting best practice. . . . One such pragmatic approach might be to provide an informaticist service, in which a specialist individual (informaticist) or group could assist general practitioners, nurses, and other health professionals to answer questions arising in day to day practice . . . Preliminary research from the United

States suggests that such services are effective and cost effective in improving practice in the hospital setting (p. 524).

Greenhalgh, et al. provide examples of two types of informaticist services – one that was a less ‘personal’ university based answering service and one that involved more direct contact between the informaticist and the local practitioners. Although this is a potentially promising approach it would seem to require substantial funding (number of informaticists), some method of prioritizing which clinical questions were answered (if the service was popular), and substantial consideration regarding the training of informaticists (c.f., Plutchak, 2000).

Conclusion

This selective review points out that in addition to generally increasing WWW use among the general population and among social workers, the quality of the information available on the WWW is becoming a concern of a substantial number of investigators. These investigators are grappling with how to study and how intervene with this problem.

There have been calls for some time to assess web based information using widely accepted gold standards (e.g., meta-analyses of randomized trials, Wyatt, 1997). Yet, how do we proceed in those areas of medicine and what are probably larger subsets of the knowledge base in social work where we lack even sufficient primary studies to do conclusive meta-analyses? When there are insufficient empirical findings to aggregate, do we move to expert ratings of the

limited information in question? If yes, then we need to find groups of experts with acceptable levels of interrater reliability (c.f., Craigie, Loader, Burrows & Muncer, 2002).

Simon (1997) in his discussion of bounded rationality contrasts an economic view where the actor *maximizes* by making a decision based on examination of all possible alternatives with the actor who *satisfices* by making a decision that is 'good enough' (c.f., Agosto, (2002) for an application of this theory to WWW searching). In terms of the ongoing professional life of social workers as information managers, some decisions may allow for maximization. For instance, new, widely accepted practice guidelines for clients with matching profiles (diagnosis, demographics, etc.), and the local ability to deliver the recommended intervention may emerge. Yet, how often will this happen? Social work lives in a world of multiproblem clients with limited resources, often from unstudied groups, with pressing immediate needs, in limited resource environments. Social workers who satisfice in the trenches may be the best we can hope for as a profession (c.f., Gorman, et al., 2000).

This does not mean that the social worker should rely primarily on 'practice wisdom' handed down from supervisors and colleagues. We would assert that a more satisficing strategy is possible, where the social worker acquires better information retrieval (searching and assessing) skills and seeks out answers from WWW based resources available on their desktop for a subset of the problems they encounter. While they would still exchange practice

wisdom locally, they would now, more routinely go out into the world to acquire the information they need to improve their solution to local practice problems.

While perhaps not the optimal approach of completely empirically justified practice, this is an approach that moves practice beyond its current level. That is, to make it more empirical – more *satisfying* – by shifting the quality of information used by social workers upward. A graphical conceptualization of this approach is presented in Figure 1. The goal of the approach is to increase the quality of the information selected by the practitioner. Gorman, et al. (2000)

conclude in part that:

[B]ecause digital libraries can provide vast amounts of information at the times and places where information intensive tasks are performed, they have the potential to transform the work of those whose information management and decision making are tightly integrated with the physical operations they perform” (2000, p. 25-6).

The authors agree with this assessment. Yet, if this transformation is to effectively change the quality of services delivered, the quality of information applied to particular clinical tasks must be increased.

References

- Agosto, D. E. (2002). Bounded rationality and satisficing in young people's Web-based decision making. *Journal of the American Society for Information Science and Technology*, 53, 16-27.
- Ash, J. S., Gorman, P. N., Lavelle, M., Lyman, J., Delcambre, L. M., Maier, D., Bowers, S., & Weaver, M. (2001). Bundles: Meeting clinical information needs. *Bulletin of the Medical Library Association*, 89, 294-97.
- Barnett-Queen, T. (2001). Attitudes and opinions regarding the use of the Internet for continuing education among social workers. *Journal of Technology in Human Services*, 18, 145-169.
- Bergman, M. K. (2000). The deep web: Surfacing hidden value. Retrieved 6/4/02 from: <http://www.press.umich.edu/jep/07-01/bergman.html>
- Borges, A. A. H., Cervi, P. M., de Arcaya, T. A., Gaspar, Guardado, M. A. G., Rabaza, A. R., & Sosa, A. J. (2001). Rates of compliance with the HON Code of conduct versus number of inbound links as quality markers of pediatric web sites. Retrieved 6/4/02 from :
<http://mednet2001.drmm.uniud.it/proceedings/paper.php?id=75>
- Burrows, S., Moore, K. M., & Lemkau, H. L. (2001). Creating a Web-accessible, point-of-care, team-based information system (PoinTIS): the librarian as publisher. *Bulletin of the Medical Library Association*, 89, 154-64.

Craigie, M., Loader, B., Burrows, R., & Muncer, S. (2002). Reliability of health information on the Internet: An examination of experts' ratings. *Journal of Medical Internet Research*, 4, 1. Retrieved 5/27/02 from:
<http://www.jmir.org/2002/1/e2/index.htm>

Delcambre, L., Maier, D., Bowers, S., Weaver, M., Deng, L., Gorman, P., Ash, J. Lavelle, M, & Lyman, J. A. (2002). Bundles in captivity: An application of superimposed information. Retrieved 7/4/02 from:
<http://www.cse.ogi.edu/~shawn/captivebundles.pdf>

Ely, J. W., Osheroff, J. A., Ebell, M. H., Chambliss, M. L., Vinson, D. C., Stevermer, J. J., Pifer, E. A. (2002). Obstacles to answering doctors' questions about patient care with evidence: qualitative study. *BMJ*, 324, 710-35. Retrieved 7/4/02 from:
<http://bmj.com/cgi/reprint/324/7339/710.pdf>

Eysenbach, G., & Kohler, C. (2002). How do consumers search for and appraise health information on the world wide web? Qualitative study using focus groups, usability tests, and in-depth interviews. *BMJ*, 324, 573-77. Retrieved 8/25/02 from:
<http://bmj.com/cgi/content/full/324/7337/573>

Fallis, D. & Fricke, M. (2002). Indicators of accuracy of consumer health information on the Internet: a study of indicators relating to information for managing fever in children in the home. *Journal of the American Medical Informatics Association*, 9, 73-9.

- Fox, S. & Rainie, L. (2002). Vital decisions. Retrieved 5/31/02 from:
http://www.pewinternet.org/reports/pdfs/PIP_Vital_Decisions_May2002.pdf
- Gagliardi, A., & Jadad, A. R. (2002). Examination of instruments used to rate quality of health information on the internet: chronicle of a voyage with an unclear destination. *BMJ*, 324, 569-73. Retrieved 3/12/02 from:
<http://bmj.com/cgi/content/full/324/7337/569>
- Gambrill, E. D. (2001). Educational policy and accreditation standards: Do they work for clients? *Journal of Social Work Education*, 37, 226-39.
- Gorman, P., Ash, J., Lavelle, M., Lyman, J., Delcambre, L., Maier, D., Weaver, M., & Bowers, S. (2000). Bundles in the wild: Managing information to solve problems and maintain situation awareness. *Library Trends*, 49, 266-89.
- Grandage, K. K., Slawson, D. C., & Shaughnessy, A. F. (2002). When less is more: A practical approach to searching for evidenced-based answers. *Journal of the Medical Library Association*, 90, 298-304.
- Greenhalgh, T., Hughes, J., Humphrey, C., Rogers, S., Swinglehurst, D. & Martin, P. (2002). A comparative case study of two models of a clinical informaticist service. *BMJ*, 324, 524-9. Retrieved 7/4/02 from:
<http://bmj.com/cgi/content/full/324/7336/524>
- Griffiths, K. M. & Christensen, H. (2000). Quality of web based information on treatment of depression: Cross sectional survey. *BMJ*, 321, 1511-5.

Holden, G., & Barker, K. M. (1990). Potential for technological dependency: An example. *Social Work Research and Abstracts*, 26, 35-6.

Horrigan, J. B. & Rainie, L. (2002a). Getting serious online. Retrieved 5/31/02 from: http://www.pewinternet.org/reports/pdfs/PIP_Getting_Serious_Online3ng.pdf

Horrigan, J. B. & Rainie, L. (2002b). The broadband difference: How online Americans' behavior changes with high-speed Internet connections at home. Retrieved June 29, 2002 from: http://www.pewinternet.org/reports/pdfs/PIP_Broadband_Report.pdf

Hughes, R. Joo, E., Kentall, S. R. & Ulishney, K. (1999). Access and use of information technology by human service providers. *Journal of Technology in Human Services*, 16, 1-16.

Impicciatore P, Pandolfini C, Casella N, Bonati M. (1997). Reliability of health information for the public on the world wide web: systematic survey of advice on managing fever in children at home. *BMJ*, 314, 1875-79

Janes, J., Hill, C., & Rolfe, A. (2001). Ask-an-expert services analysis. *Journal of the American Society for Information Science and Technology*, 52, 1106-21.

Jansen, B. J. (2000). The effect of query complexity on Web searching results. *Information Research*, 6, 1. Retrieved 7/3/02 from: <http://informationr.net/ir/6-1/paper87.html>

Jansen, B. J., Spink, A. & Saracevic, T. (2000). Real life, real users, and real needs: a study and analysis of user queries on the web. *Information Processing and Management*, 36, 207-227.

Kim, P., Eng, T. R, Deering, M. J., Maxfield, A. (1999). Published criteria for evaluating health related web sites: review. *BMJ*, 318, 647-649

Korgen, K., Odell, P. & Schumacher, P. (2001). Internet use among college students: Are there differences by race/ethnicity. *Electronic Journal of Sociology*, 5, 3. Retrieved 10/4/01 from:
<http://www.sociology.org/content/vol005.003/korgen.html>

Kunst, H., Groot, D., Latthe, P. M., Latthe, M., & Khan, K. S. (2002). Accuracy of information on apparently credible websites: survey of five common health topics. *BMJ*, 324, 581-2. Retrieved 6/27/02 from:
<http://bmj.com/cgi/content/full/324/7337/581>

Larsen, E. & Rainie, L. (2002). The rise of the e-citizen: How people use government agencies' Web sites. Retrieved 5/31/02 from:
http://www.pewinternet.org/reports/pdfs/PIP_Govt_Website_Rpt.pdf

Lenhart, A., Simon, M., & Graziano, M. (2001). The Internet and education: Findings of the Pew Internet & American Life Project. Retrieved 5/31/02 from:
http://www.pewinternet.org/reports/pdfs/PIP_Schools_Report.pdf

Levinson, D. (1983). Information, computers and clinical practice. *Journal of the American Medical Association*, 249, 607-9.

- Lucas, W., & Topi, H. (2001). Form and function: The impact of query term and operator usage on Web search results. *Journal of the American Society for Information Science and Technology*, 53, 95-108.
- McLaughlin, L. (2002, July). The straight story on search engines. *PC World*, 115-24.
- McClung, H. J., Murray, R. D., & Heitlinger, L. A. (1998). The Internet as a source for current patient information. *Pediatrics*, 101, 6, e2.
- Meric, F., Bernstam, E.V., Mirza, N. Q., Hunt, K. K., Ames, F. C., Ross, M. I., Kuerer, H. M., Pollock, R. E., Musen, M. A., & Singletary, S. E. (2002). Breast cancer on the world wide web: cross sectional survey of quality of information and popularity of websites. *BMJ*, 324, 577-81. Retrieved 5/30/02 from: <http://bmj.com/cgi/content/full/324/7337/577>
- National Telecommunications and Information Administration (2000). Falling through the net: Toward digital inclusion.. Retrieved 10/05/01 from: <http://www.ntia.doc.gov/ntiahome/digitaldivide/>
- Pandolfini, C. & Bonati, M.(2002). Follow up of quality of public oriented health information on the world wide web: Systematic re-evaluation. *BMJ*, 324, 582-3. See correction at: <http://bmj.com/cgi/content/full/324/7347/1185>
- Pew Internet and American Life (2000). Wired workers: Who they are and what they're doing online. Retrieved 5/30/02 from: <http://www.pewinternet.org/reports/toc.asp?Report=20>

Plutchak, T. S. (2000). Informationists and librarians. *Bulletin of the Medical Library Association*, 88, 391-2.

Reid, W. J. (2002). Knowledge for direct social work practice: An analysis of trends. *Social Service Review*, March, 6-33.

Rieh, S. Y. (2002). Judgment of information quality and cognitive authority in the Web. *Journal of the American Society for Information Science and Technology*, 53, 145-61.

Search Day (2002, June 17). FAST sprints past Google in search engine size wars. #291. Retrieved 6/17/02 from:

<http://searchenginewatch.com/searchday/searchday.html>

Sherman, C., & Price, G. (2001). *The invisible web: Uncovering information sources search engines can't see*. Medford, NJ: Information Today, Inc.

Silverstein, C., Henzinger, M., Marais, H. & Moricz, M. (1999). Analysis of a very large Web search engine query log. *SIGIR Forum*, 33, 6 -12.

Simon, H. (1997). *Administrative behavior*, 4th Ed. New York: Free Press.

Taylor, H. (2002). Internet penetration at 66% of adults (137 million) nationwide. The Harris Poll, 18. Retrieved 5/31/02 from:

http://www.harrisinteractive.com/harris_poll/index.asp?PID=295

Wathen, C. N. & Burkell, J. (2002). Believe it or not: Factors influencing credibility on the Web. *Journal of the American Society for Information Science and Technology*, 53, 134-44.

Westberg, E. E., Miller, R. A. (1999). The basis for using the Internet to support the information needs of primary care. *Journal of the American Medical Informatics Association*, 6, 6-25.

Wilson, P. (2002). How to find the good and avoid the bad or ugly: a short guide to tools for rating quality of health information on the internet. *BMJ*, 324, 598-602. Retrieved 3/12/02 from:
<http://bmj.com/cgi/content/full/324/7337/598>

Wyatt, J. C. (1997). Commentary: measuring quality and impact of the World Wide Web. *BMJ*, 314, 1879-81.

Figure 1. Conceptualization of the information system and the information quality improvement goal.

